Organization: University of Colorado at Boulder

Title: Biofluidic Transport and Molecular Recognition in Polymeric Microdevices

MTO **Symbiosys**

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Project Goals

The overall goal of the proposed work is the development and characterization of polymeric microfluidic components and devices fabricated by living-radical photopolymerization (LRP) to impart desired geometries, material properties, and chemical functionalities. The unique advantages of LRP include the ability to fabricate complex three-dimensional geometries with covalently bonded layers, the ability to modify selectively surfaces with chemical grafts of different functionalities in desired spatial patterns, and the versatile properties of polymeric materials for applications in biofluidic transport and molecular recognition.

Technical Approach

The first task is *Polymeric Component Design and Fabrication*, in which living-radical photopolymerization (LRP) will be used to control the geometry and chemistry of different polymeric microfluidic components. The second task is *Biofluidic Transport Modeling and Characterization*, in which biofluidic pumping, mixing, and separation in polymeric microdevices formed by LRP will be demonstrated and characterized. Specific demonstrations of progress on the first two tasks include surface-patterned two-dimensional polymeric channels, three-dimensional polymeric geometries, responsive-polymer micropumps and valves, electroosmotic micropumps, and microporous polymers for filters and mixers, each fabricated by living-radical photopolymerization.

Recent Accomplishments

- 2D channels and other patterns fabricated by living-radical photopolymerization
- Polymer surfaces photopatterned with grafted hydrogels exhibiting pH-dependent swelling
- Preliminary demonstration and characterization of macroscale pump based on dynamic swelling of fluid-responsive hydrogels

Six-Month Milestones

- Simple 3D channel fabricated by living-radical photopolymerization (LRP)
- Patterned surface modification (hydrophilic/hydrophobic, positive/negative/neutral) through LRP
- Fluid-responsive polymeric micropump and microvalve formed by LRP
- Experimental/theoretical characterization of particle-wall transport interactions in narrow microchannels with unmodified walls

Team Member Organizations

N/A

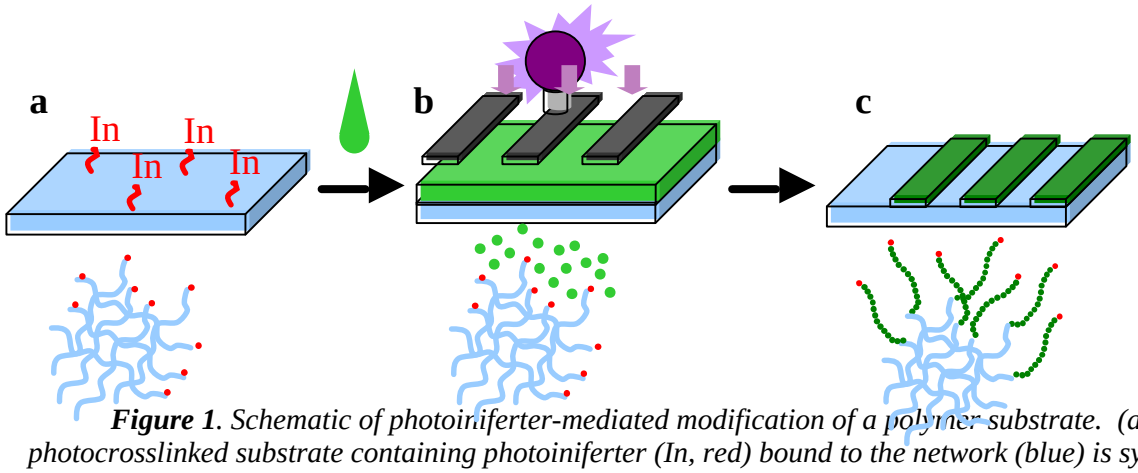

***Figure 1**. Schematic of photoiniferter-mediated modification of a polymer substrate. (a) A photocrosslinked substrate containing photoiniferter (In, red) bound to the network (blue) is synthesized. (b) Additional monomer (green) is added to the surface and exposed to UV light through a photomask. (c) Covalently-bound polymer (green) is grown from the substrate (blue) surface in the regions exposed to light.*

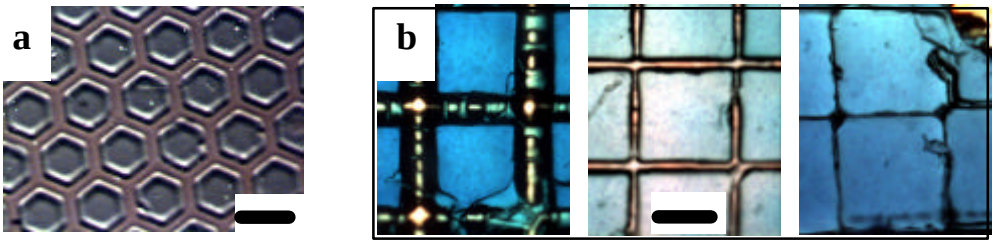

***Figure 2.** Polymer surfaces modified by photoiniferter-mediated grafting. (a) Hydrophilic PEG monomer grafted to a hydrophobic surface (scale bar: 100 ? m). (b) pH-sensitive poly(methacrylic acid) grafted to a hydrophobic substrate exhibits different swelling in response to pH variations (left: pH2; middle: pH7; right: pH10; scale bar: 250 ? m).*

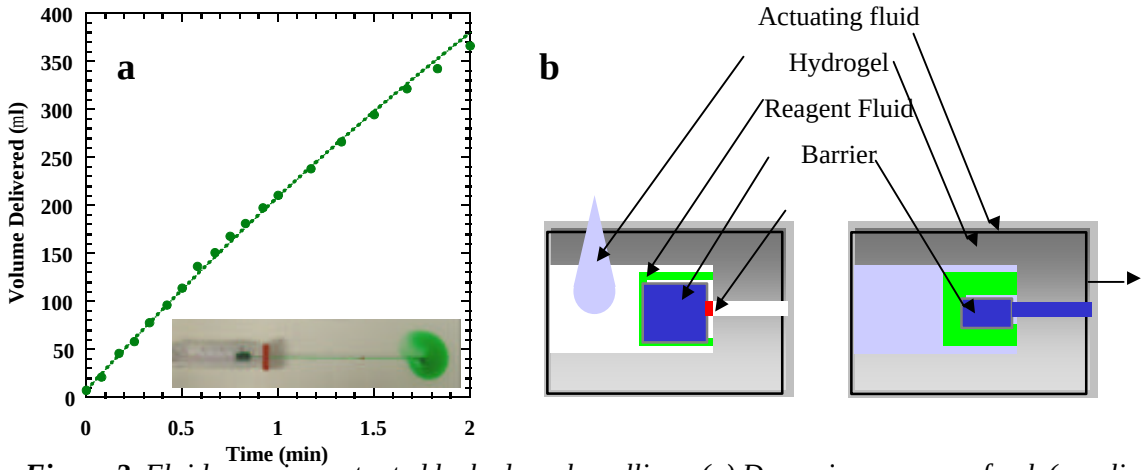

***Figure 3**. Fluid pumping actuated by hydrogel swelling. (a) Dynamic response of poly(acrylic acid) particles swollen in water to deliver fluid from a reservoir (the symbols are experimental data and the curve is a model prediction). (b) The design for a hydrogel pump fabricated by LRP includes a depot for the actuating fluid. The swelling hydrogel then constricts a reservoir containing the reagent fluid to be pumped through the channel. The barrier (which may be physical or a simple hydrophobic patch) yields due to pressure from the swelling hydrogel*